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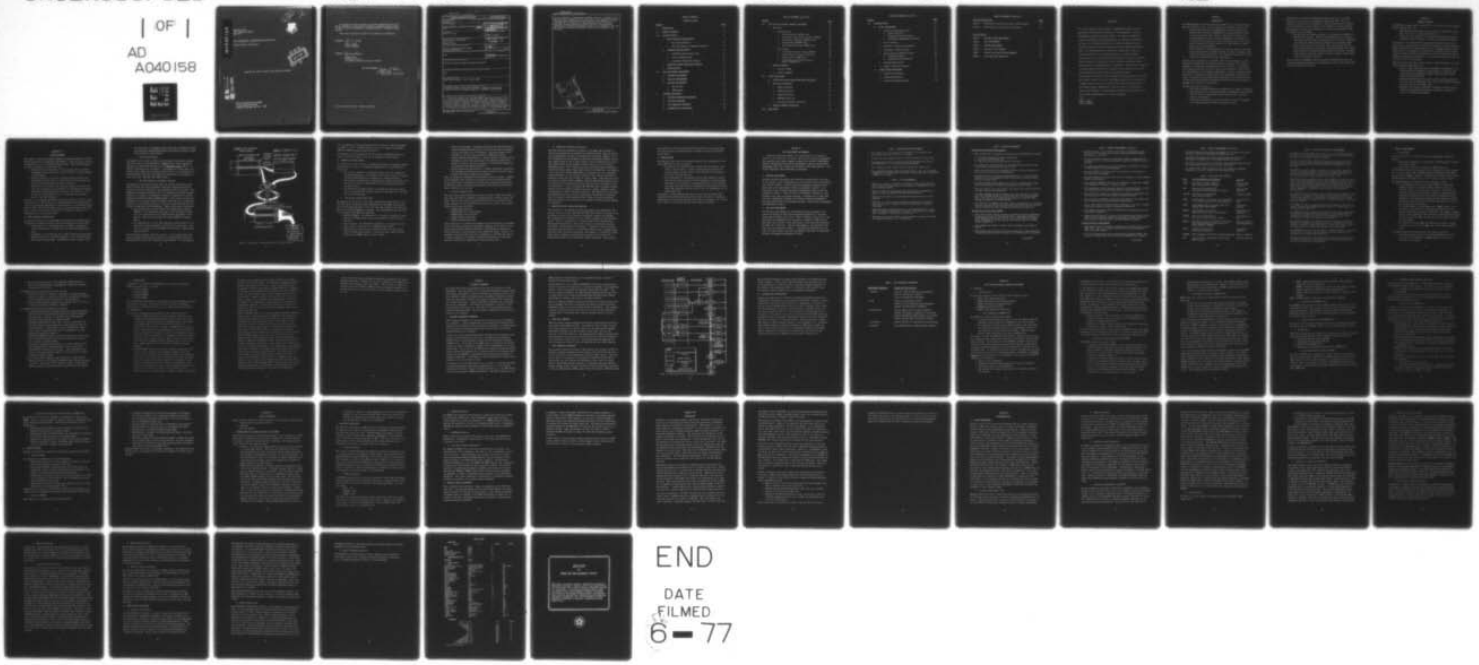

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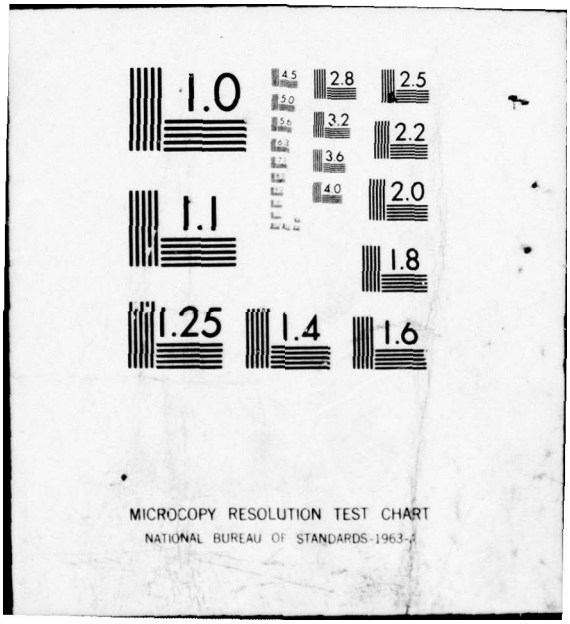
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Final Technical Report
May 1977

IPAC REQUIREMENTS INTERPRETATION SYSTEM (IRIS)

Martin Marietta Corporation

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20. ABSTRACT *(Continue on reverse side if necessary and identify by block number)*

This report describes the IPAC Requirements Interpretation System (IRIS), an automated intelligence data processing system whose primary function is to support an Indications and Warning Center's actions to obtain more information on observed events of interest. The system facilitates a user's transition from his information requirement, or query, to the identification of specific information system outputs; and through an evaluation of the information system, to the initiation of acquisition of selected outputs. The system works with

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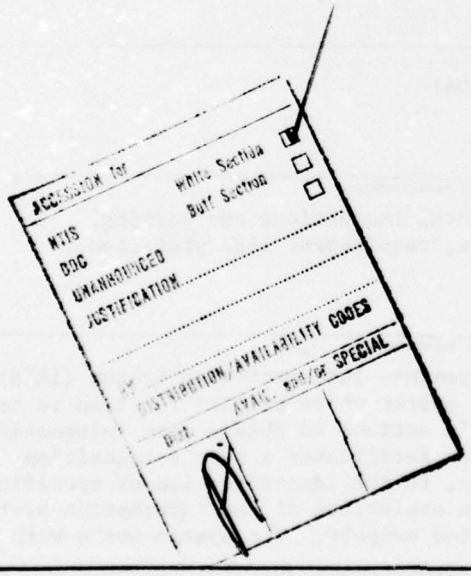
the user by means of a comprehensive man-machine interface. Available to the user are various components of a data base which contain summaries of relevant information system characteristics and signatures of the observables of the query subjects. Protocols for accessing these information systems are described. Analysis techniques to enable evaluation of data acquisition opportunities for different information systems are also available to the user. Both collection systems and intelligence files can be accommodated in the data base.



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EVALUATION

This final technical report presents a comprehensive summary of work performed by Martin Marietta Aerospace in the development of the IPAC Requirements Interpretation System (IRIS). This work is significant because it provides an automated capability for interactive information retrieval to aid PACOM Watch Analysts in rapidly focusing on the best data and collection resources in response to their immediate information needs. The system supports the analyst by allowing him to specify a structured hierarchy of information subjects at a display terminal. Following this, the system computes the pertinence of data and collection sources stored in its data base to these information subjects, assigns rating factors, and displays these to the analyst. This informs the analyst of further source data access or collection system tasking, done outside the IRIS system, that will fulfill his information needs.

The objective of the effort was to implement a prototype system of hardware and software, deliver it to the Intelligence Center, Pacific, provide user training, and allow the user to exercise and evaluate the system with a view toward eventual augmentation of the data base to cover more data sources and collectors. The final report describes this prototype system and contains recommendations for future improvement.

John V. Weber

JOHN V. WEBER
Project Engineer

SECTION I

INTRODUCTION

The IPAC Requirements Interpretation System (IRIS) is an all-source intelligence data support system. It was developed to accomplish two objectives:

- o Increase the timeliness and completeness of the Indications and Warning (I&W) function of PACOM/IPAC by providing the Watch access to sensor and source data related to the current situation and thereby enhance his ability to make judgements on the feasibility of special data processing or ad hoc collections and, in turn, augment his ability to initiate requests for data through the appropriate sensor owner/operator.
- o Assist analysts in the determination of the full potential of information system assets (national, unified, specified or component command) which may be applicable to his problem, and provide aid to the analysts in formatting of proper requirements.

IRIS has been implemented on a dedicated PDP-11/45 mini-computer in which application software and required data bases are resident. The system is bi-modal to accommodate both experienced and novice users. A structured event sequence mode leads the novice user, with explanatory tutorials from his specification of an information requirement, or query, through the identification of information system outputs to the generation of tasking messages. A relatively unstructured option mode permits the experienced user to select only those analysis procedures and data files for review that are germane to the solution of his problem.

The IRIS data base consists of:

- o Files which the IRIS application software uses to enable a transition from user queries to the identification of information system outputs.
- o Files in which the information system characteristics and capabilities are detailed.
- o Files which contain data required to support the user's validation of information systems' outputs selected for access.

IRIS/IOC (Initial Operational Capability) requires the user to actively participate in the review of information system output data, and in the analysis of information system operation. He also makes decisions relative to the initiation of actions leading to the acquisition of these outputs. This apparent excessive user interaction in the initial operations of IRIS, is supported by two arguments:

- The IRIS user must develop confidence in the technical integrity of IRIS data and analyses. This can be accomplished by his review of information system-related data which would be the basis of automatic data processing (ADP) selection procedures in a more mature IRIS.
- Only a day-to-day user can identify those selection and decision criteria which should be automated. Experience suggests that judgements influenced by IRIS data characterized by subtleties in meaning which cannot be concisely reduced to words or numbers, should remain within the purview of the user.

The evolution into IRIS/FOC (Final Operational Capability) with more completely automated operations, will be determined by users' needs rather than an a priori operations analysis.

SECTION II

PROBLEM STATEMENT

The IPAC Watch, among other responsibilities, is required to review message traffic with the object of:

- o Identifying possible anomalies which cannot be explained by available resources or by other routine data, and
- o Taking the action required to initiate the acquisition of that information which will explain or clarify the identified anomalies.

The volume of such traffic having uncertainties increases prior to and during crises. The capability of the Watch personnel to specify new information requirements in a timely manner may not be adequate for the proper support of J-2. Furthermore, the large array of products from all potentially applicable collection disciplines is such that solutions to new information requirements identified by a given Watch team may not be the best solutions to the current problem.

These two difficulties have a common problem. Watch personnel do not have readily available data which will:

- o Permit a timely transition from an information requirement to the identification of information system outputs, or products, that could satisfy the requirement (without regard for any specific collection discipline bias);
- o Provide enough data about the output and the producing system so that there is a rational basis for a decision to initiate the acquisition of specific information; and
- o Encompass the variety of potential information sources, for both military and non-military situations, necessary to support all types of information requirements.

SECTION III

SOLUTION CONCEPT

The elements of the stated problem suggested a sequenced approach to accommodate the solution of information requirements, since such queries could not be specified a priori in the IRIS design criteria. This solution sequence was seen to consist of four discrete steps:

- Transition from a stated query to the identification of specific information system outputs which could partially or totally satisfy the requirement.
- Review or analysis of relevant information system technical and operational characteristics to verify which of the identified outputs constitute potentially reasonable solutions.
- Selection of one or more of the solutions derived in the first two steps and initiation of the acquisition of the identified output(s).
- Development and maintenance of a record of the problem; i.e., the uncertainty that stimulated the use of IRIS and the consequent actions under IRIS direction.

Of these, it was apparent that IRIS could actively support the first, second, and fourth steps. The third step is strongly dependent on judgement which could only be properly implemented in an ADP system on an evolutionary basis. However, IRIS could provide limited support to the second part of the third step. The four step conceptual approach was developed as described in Subsections A, B, C and D that follow.

A. QUERY SOLUTION IDENTIFICATION

Potentially the first step, (requirement interpretation and identification of applicable information system outputs) was partitioned into two tasks:

- Representation of a substantive query to IRIS in a manner that would allow software to operate on it and identify candidate solutions.
- Development of a working data base in IRIS containing potential displayable solutions to substantive queries. Such a data base would have to grow incrementally. An IOC/IRIS could not include a data

base that would be permanently valid since newer information systems are continually emerging and outputs from existing systems are sometimes replaced by other outputs.

1. Query Representation

The approach to the first of these tasks was based on the general premise that every query is characterized by a subject (about which something is desired to be known) and a discrete set of information needs (what is required to be known about the subject). The elements of a given query, correlated with an IRIS subject catalog element and one or more elements in an IRIS information need file would permit the translation of the presented query into terms compatible with IRIS software.

2. Data Base Support of Candidate Solutions

The approach to the second of these tasks was strongly influenced by the need to combine and screen information concerning intelligence subjects, potential collection disciplines, and information needs of the query. The merging and subsequent screening process to determine and present candidate solutions to information requirements (queries) is referred to as the Requirement Interpretation Matrix (RIM) analysis. This concept involves the development of two separate analyst-generated data files, with a strong requirement to include more than just a token set of data that would be sufficient to demonstrate IRIS methodology. These two data files constitute:

- The determination, for each element of the IRIS Subject Catalog (SUCAT), of the information needs which could be satisfied by any collection discipline that is compatible with observables of the subject. This file was assigned the acronym SUMAT (for Subject Matrix).
- The determination, for each IRIS information system output, of the needs which could be satisfied, and how well, by the output. This file was assigned the acronym SYSMAT (for Information System Output Analysis Matrix).

The RIM analysis approach, depicted in Figure 1, only required about 1040 subject analyses (multiplied by an average of nine associated collection disciplines) plus about 140 information system analyses. If this approach

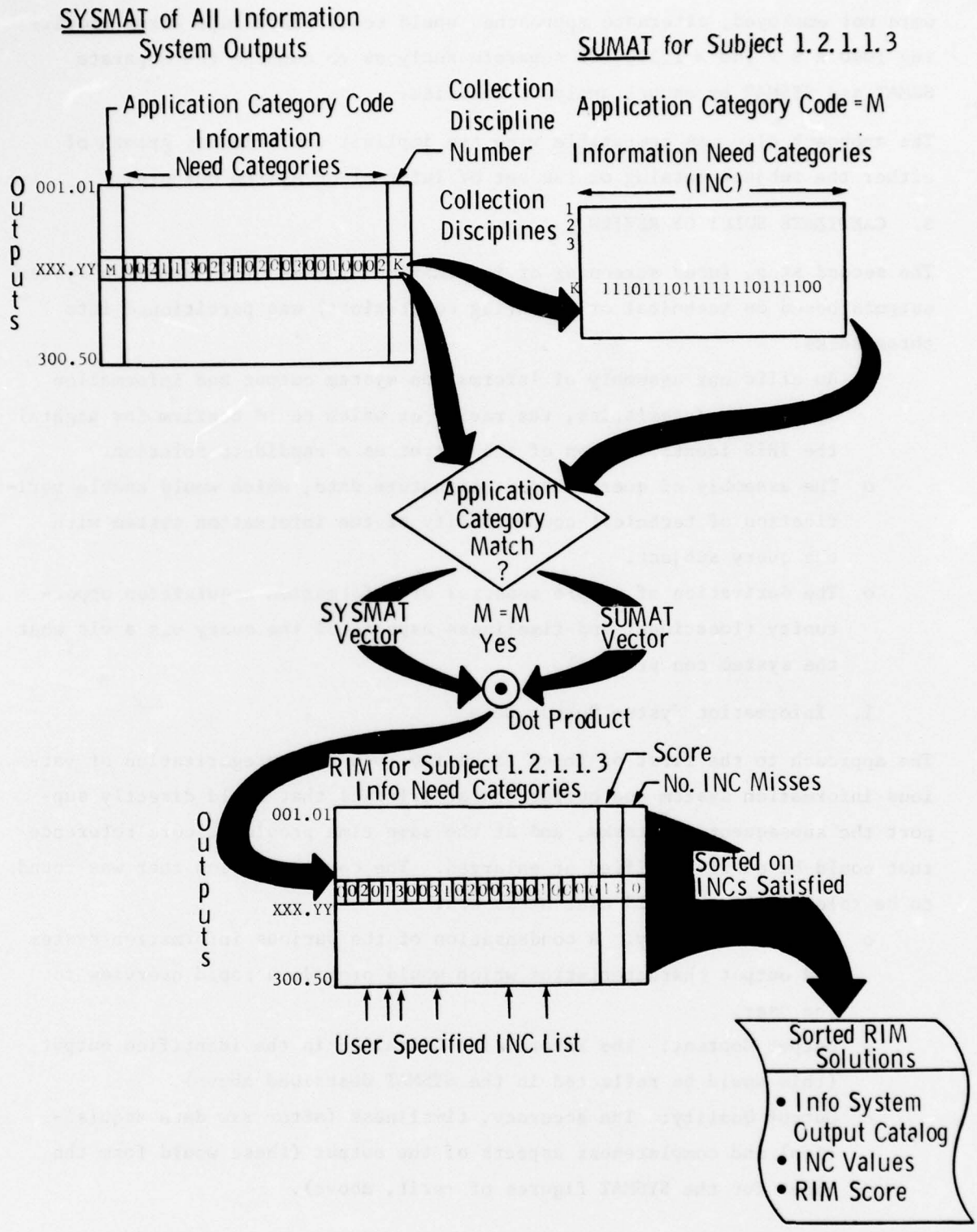

Figure 1 Requirements Interpretation Matrix (RIM) Analysis

were not employed, alternate approaches would result in a data array requiring 1040 x 9 x 140 = 1,310,400 separate analyses to combine the separate SUMAT and SYSMAT by manual analysis exercise.

The approach also was compatible with the implicit evolutionary growth of either the subject catalog or the set of information system outputs.

B. CANDIDATE SOLUTION REVIEW

The second step, (user screening of information systems or information system outputs based on technical or operating constraints) was partitioned into three tasks:

- o An efficient assembly of information system output and information system characteristics, the review of which could confirm (or negate) the IRIS identification of the output as a candidate solution.
- o The assembly of query subject signature data, which would enable verification of technical compatibility of the information system with the query subject.
- o The derivation of simple measures of information acquisition opportunity (locational and timeliness aspects of the query vis a vis what the system can provide).

1. Information System Output Data

The approach to the first of these tasks involved the categorization of various information system and output characteristics that would directly support the subsequent two tasks, and at the same time provide a core reference that could be easily modified or enlarged. The categorization that was found to be relevant to the IRIS user needs was:

- o Executive Summary: A condensation of the various information system and output characteristics which would provide a rapid overview to the user.
- o Output Content: The information contained in the identified output (this would be reflected in the SYSMAT described above).
- o Output Quality: The accuracy, timeliness (after raw data acquisition) and completeness aspects of the output (these would form the bases for the SYSMAT figures of merit, above).

- o Output Access Methods: Accessing protocol and the identification of required standard message forms to be used in the event the acquisition of this output is to be initiated. This would support accomplishment of the third step discussed in Subsection B below.
- o System Technical Characteristics: Those technical descriptors of the information system that would support the signature compatibility analysis related to the query signature, or that may be required in an acquisition opportunity evaluation.
- o System Operational Characteristics: General operational constraints, the knowledge of which could facilitate a decision to pursue a more detailed acquisition opportunity evaluation.

These six categories represented an acceptable top level structure. However, it was recognized that the data for different kinds of information system outputs would differ significantly and that there should be provisions for an informal structure of the data presentation which permits easy modifications or additions to the data.

2. Subject Signature Data

The second task concept identified the need for arrays of data that would relate query with types of signature or phenomenologies to which a sensor can react. These arrays would be associated with each of the collection disciplines represented by the identified collection system output. Five subject signature files were identified:

- o ELINT (Radar emissions)
- o PHOTINT (Resolution requirements)
- o RADINT (Radar cross-sections)
- o ACINT (Acoustic emissions)
- o IRINT (Infrared emissions)

These data would be so derived and assembled that the IRIS user could readily verify compatibility between the applicable signature of the subject of his current query and any technical attribute of the information system that would be related to the acquisition of the identified output. Further, the assembly of such data should not be so transparent to the IRIS user that he is unable, drawing on his specific intelligence background, to critically assess the accuracy and completeness of these signature data.

3. Acquisition Opportunity Analysis

The third task was identified as requisite to an IRIS user's ability to assess the practicality of accessing the identified output, when the timeliness and geographic specifics of his query are considered. However, it was also recognized that an information acquisition opportunity analysis must be kept simple enough so that it would remain a tool to facilitate the overall IRIS analysis flow and not become a central analysis as in a collection management system. This criterion dictated the need for simple information system performance measures and simple inputs by the IRIS user. For example, in the case of an airborne ELINT system, the feasibility of its employment would be measured by total possible collection time, and the user would be required to input only the location of a point target. Sophistications such as terrain or weather effects, EMCON or platform availability would be typical omissions in an analysis only having the objective of determining relative feasibility. It was recognized that IRIS may never be capable of maintaining current information system status (e.g., health, readiness, sensor configurations or modes, and weather effects). The acquisition of such data from authoritative sources would involve delays that would be inconsistent with the objective responsiveness of IRIS. Hence, this type of analysis should be limited to only that which is required to achieve relative measures of performance.

C. IDENTIFIED OUTPUT ACQUISITION REQUESTS

With reference to the sequenced approach discussed at the begining of this section, the part of the third step that IRIS could support is related to the development of specifically applicable acquisition requests and messages. This development is consistent with the protocol required by the information system. This was recognized as a convenient way in which the IRIS user, having made the decision to access one or more of the identified outputs, could draft a formalization of his request. Inclusion of the directed and information addresses and use of recognized wording in such a message draft would facilitate the actual processing. The concept to be developed in IRIS would involve assembly of the appropriate message forms, executed for a sample message, and with the applicable outputs identified. These message

forms would be stored in dedicated files and would be displayed only when the user had made a conscious decision to request a specific information system output.

D. RECORD KEEPING

The fourth and last step in the sequenced approach was recognized as a necessary IRIS activity for two reasons:

- o The quantity and variety of data the user could be expected to encounter, particularly if several information system outputs were being evaluated, dictate a need to save pertinent facts germane to the output selection decision.
- o The documentation of the analysis process (and consequent results) that the user would carry out from the statement of the information requirement to the selection and requesting of one or more outputs, would have historical value in subsequent review of Watch activities. These IRIS transaction results would in fact be complementary to the regular Watch log.

Accordingly, it was determined that there be some type of "scratch pad" capability within IRIS that should exist as long as a specific information requirement was being worked and that there also be a permanent log, created from a subset of the scratch pad data and permanently retained.

SECTION IV

IRIS DEVELOPMENT REQUIREMENTS

IRIS development requirements were established by the integrated definition and refinement of software, data base and analysis requirements. IPAC specified the original computer hardware and top-level requirements. Detailed requirements were derived from analyses conducted during method development, data file assembly and preliminary IRIS demonstrations. This section summarizes these development requirements.

A. SOFTWARE REQUIREMENTS

The IRIS software requirements were defined and established on the basis of the computer system, development plan, and analysis derived requirements. The computer hardware, software system and programming language requirements used in the development of IRIS are summarized in Table 1. An extraction of the top-level operational requirements stated by IPAC are presented in Table 2. These two sets of requirements represent the IRIS baseline at the time of contract go-ahead. A detailed list of data base structure, man/machine interface, and software operation requirements were then derived from in depth design analyses. These derived requirements are summarized in Table 3.

B. DATA BASE REQUIREMENTS

The data base requirements were established through development of an operational method for IRIS and the subsequent definition of necessary source data to support the process. Table 4 presents a tabulation of the data base files determined to be necessary to support the IRIS process. This table also includes a brief description of the functional importance and IRIS use of each file. Specific requirements of the individual data base files are presented in Table 5. Combining the requirements of this table with the software structural requirements (see Table 3) established the major development requirements for IRIS.

TABLE 1 COMPUTER SYSTEM REQUIREMENTS

- The software shall be implemented for operation on a DEC PDP 11/45 mini-computer with 64K words of core storage.
- The mass storage subsystem shall be a RP-04 disk and two RK-05 disks.
- The input/output (I/O) functions shall be accomplished with either a LA-36 DECwriter or a Univac 1652 Dual Display Scope.
- The computer software system shall be the RSX-11D, Version 6B.
- The programming language shall be Fortran IV Plus. The use of assembly language to circumvent excessive software complications must be justified to IPAC prior to usage.

TABLE 2 IPAC REQUIREMENTS

- IRIS shall be simple to operate by any Watch or I&W analyst personnel, few of whom shall be expected to be proficient in operating an interactive computer system.
- IRIS shall lead the inexperienced user through the accomplishment of specific screening, analytic and data review functions.
- IRIS shall be capable of facilitating data base growth and of facile updating.
- IRIS shall be a stand-alone system with the data base a sufficient source for the user to obtain a solution satisfying an information requirement.
- IRIS shall produce rapid solutions, for the experienced user, to the posed information requirements. Inherently long analyses or reviews shall be capable of being omitted by the user.
- IRIS shall provide the capability to accumulate the results of its use for permanent retention; i.e., an IRIS Log.

TABLE 3 DERIVED REQUIREMENTS

Data Base File Structure Requirements

- IRIS software shall be capable of working with three distinct file types:
  1) Structured indentured-textural information,
  2) Structured data formats, and
  3) Free-form textual data with asterisk divisions.
- The format shall be established for each structured file that is used to store IRIS computational and control data.
- Structured files shall be re-organized by IRIS file build software for ease of access during run-time processing.
- The SUCAT shall be a structured indentured-textual file that provides retention for an intelligence subject catalog with increasing identity at each succeeding level.
- The SUMAT, SYSMAT, INC and TRACK files shall be structured data files that provide retention of IRIS computational and control data.
- Free-form textual files shall require only superficial format definition, limited to the top level structure.
- The ASCAP, MSGFORM and INC definition files shall be free-form textual files that provide retention of display data for user review purposes. These files shall not be formulated for retrieval of specific data elements by automatic processing methods.
- The SYSCAT and the INTSIG files shall contain a combination of structured data and free-form textual data, and shall provide for retention of both correlation/directory data and display data within the same file.

Man/Machine Interface Requirements

- IRIS software shall exploit, as much as possible, the dual presentation capability of the Univac 1652 Display Scope. Simultaneous display of two independent sets of IRIS file data will enable rapid and accurate manual assessment by the user and thus preclude the need for complex software comparison.
- User commands and terminal controls shall be minimized and simple to execute.
- IRIS software shall provide the user the capability of selecting either a predefined sequence mode of operation or an optimal mode of operation.

(Continued)

TABLE 3 DERIVED REQUIREMENTS (Continued)

- The IRIS subjects and information needs shall be displayed for user specification of elements most closely representing the information requirement of the user.

- Software candidate solutions from the RIM screening process shall be displayed for user review and subsequent selection of ASCAP files to be reviewed.

- User designated ASCAP files shall be displayed and reviewable by means of simple paging and scrolling commands.

- Applicable INTSIG information shall be displayed for the subject of the information requirement.

- Applicable COLOP user instructions shall be displayed for the information system being assessed.

- User designated MSGFORM files shall be displayed, an additional command shall transfer this display to hardcopy output.

- User designated, interim analysis data shall be transferred to a Scratch file (user working file) for later review of analysis progress.

- The user shall be capable of reviewing the contents of the Scratch file (user working file) for later review of analysis progress.

- The user shall be capable of reviewing the contents of the Scratch file and the IRIS Log at any time during the IRIS process.

- Clear, user-oriented tutorials shall be displayed to the user to present instructions regarding current operational alternatives.

- User recovery procedures shall be displayed as an integral part of the system error diagnostics.

- Because the activation of the Univac 1652 Display Scope relative to the IRIS software development schedule is uncertain, software validation tests shall be conducted using a teletype-compatible terminal.

Software Operation Requirements

- IRIS software shall be designed, implemented and validated using unclassified data. The various classified data files shall be merged into IRIS on the IPAC computer.

- The user selected subject and information need categories (INCs) shall be used to automatically control the various IRIS analysis processes.

(Continued)

TABLE 3 DERIVED REQUIREMENTS (Concluded)

- o A RIM screening process shall be implemented for the identified subject and INCs, using the stored SUMAT and SYSMAT data files.
- o The COLOP subroutines shall provide quantitative data acquisition opportunity assessments for the selected information system.
- o Recording of selected data file elements in the permanent IRIS Log shall be accomplished without recourse to user interaction.
- o An optional IRIS restart capability shall be provided by permanent retention of the user's Scratch file and common block.

TABLE 4 DATA BASE FILES REQUIRED

FILE	FILE DESCRIPTION (AND FUNCTION)	IRIS USE
SUCAT	Intelligence Subject Catalog, (User Selects Level of Detail)	Controls IRIS Processes
INC	Information Need Categories, (User Selects Needs Related to Subject)	Controls RIM Analysis
INC DEF	Definitions for Above INCs, (User Familiarization)	Terminal Display
SUMAT	Subject Matrix, for Subject (Correlated INCs to Collection Discipline for each Subject)	2 Dimensions of RIM
ASCAP	Asset Capabilities or External Data File Textual Data, (User Review)	Text Review Process
SYSCAT	Info System Output Catalog, (ASCAP Summary & Function Correlation)	RIM Solutions & Directory
SYSMAT	Info System Output Matrix, (Ability of Output to Satisfy INCs)	3rd Dimension of RIM
INTSIG	Intelligence Signatures (Subject Correlated Tech Characteristics & Resolutions for ELINT, RADINT & PHOTINT)	Display for Technical Compatibility
TRACK	Predefined Flight Paths (Acquisition Analysis)	COLOP Route Profiles
MSGFORM	Sample Message Forms (Various Tasking Messages)	Display & Hardcopy
TUT	Tutorial Files, (Displayed to User During IRIS Process)	Instruct IRIS User

TABLE 5 SPECIFIC DATA BASE FILE REQUIREMENTS

- The SUCAT file shall contain a structured list of intelligence subjects arranged so as to associate general subject categories with succeeding levels of more definitive subject categories.

- The INC file shall contain candidate elements that, when selected by the user, represent what he needs to know about a particular subject. The INC definition file shall identify the basic characteristics of each INC.

- The SUMAT file shall contain a structured data array that, indexed by specific intelligence subjects, identifies the appropriate INCs that can or cannot be satisfied by a particular collection discipline or a particular category of non-perishable intelligence files.

- Each ASCAP file shall contain a descriptive summary of a specific output from a particular information system. The information systems shall be either collection systems or non-perishable intelligence files. The ASCAP file for each output shall contain information system identifiers, content and quality discussions of the output, output access methods, and, if applicable, information system technical and operational characteristics.

- The SYSCAT file shall contain an identification of the information system outputs, a brief summary of each output, and a functional directory of key displays applicable to each output. The SYSCAT shall be arranged so as to associate the outputs with their collection system or intelligence data file sources.

- The SYSMAT file shall contain structured data statements reflecting the ability of particular information system outputs to satisfy each of the information need categories.

- The INTSIG files shall contain intelligence signature data corresponding to particular selected intelligence subjects. Each subject shall be correlated with families of active emitter characteristics, imagery resolutions, or radar cross-sections, as applicable.

- The TRACK file shall be a structured data array containing identifiable PARPRO and non-PARPRO track profiles for use in airborne acquisition opportunity analyses. These data shall be assembled in terms of track identifiers and the location and altitude of the event points.

- The MSGFORM files shall contain exemplary, standard messages to facilitate communication of acquisition requirements and requirements for data distribution and special data processing.

- The Tutorial files shall contain clear, user-oriented instructions and information regarding the executable controls of sequence alternatives, selection processes, and data displays.

C. ANALYSIS REQUIREMENTS

1. Derived Data

The data to be derived by analysts during the development of IRIS will include:

- o That which is germane to the generation of RIM solutions (solutions to the posed query).
- o That which is required to complete an INTSIG data base.

The RIM-related data to be developed uner the sponsorship of this contract are: the query Subject Matrix (SUMAT) and the Information System Output Analysis Matrix (SYSMAT) elements. The SUCAT and the INCs had been derived by Martin Marietta Aerospace prior to the initiation of this contract.

The SUMAT preparation was specified by the following criteria:

- o It is acceptable for a specific subject SUMAT to reflect more capability than can be expected from a particular collection discipline within the current state-of-the-art. These data are intended to reflect state-of-the-art capability associated with a collection discipline rather than a specific information system capability. The subsequent correlations with information systems associated with the particular collection discipline, will screen out any erroneous associations.
- o The identification of an observable with a SUMAT subject, as the precursor to association of a collection discipline with the subject, should avoid nontypical situations. For example, although the non-literal emanations from an electric power generation facility could be detected by ELINT sensors, this type of sensor is not used for this purpose.
- c The logical sum of the SUMATs for IRIS subjects within the same indenture level, will be the SUMAT for the next higher indenture level.

The SYSMAT preparation was specified by the following criteria:

- o The Output Content section of the applicable ASCAP will be the source of the determination of <u>what</u> information needs may be satisfied by the output.

- o The Output Quality section of the applicable ASCAP will be the source of the determination of how well the information needs may be satisfied by the output.

The INTSIG data to be developed will serve two ends:

- o Provide descriptors of observable signatures of either individual subjects or classes of subjects as the basis for technical validation of the information systems identified in the RIM process.
- o Provide required data on potential query subjects that will be used in selected acquisition opportunity analyses.

The INTSIG data required were specified as follows:

- o For imaging signatures; the imaged resolutions required to develop the four levels of identification defined by the IRIS information need categories. This will be required for all IRIS subjects capable of being identified by imaging outputs.
- o For ELINT signatures; the radar type, function and RF ranges for each IRIS subject that may typically be associated with some type of pulsed emitter. These data will also be augmented by other radar technical descriptors that might be appropriate to a data acquisition opportunity analysis.
- o For RADINT signatures; typical radar cross sections at F and I band RFs for those IRIS subjects that could be detected or tracked by either surface or airborne radar.
- o For acoustic signatures; the frequency of a query subject primary and secondary sources, (both identified to source type) and identification of typical noise sources. These data will be developed for all IRIS subjects capable of being detected or tracked by passive acoustic sensors.
- o For infrared (IR) signatures; peak intensities of query subject emitters relative to an expected background under both day and night conditions. These data will be logically limited to those subject emitters capable of being detected by state-of-the-art IR sensors.

2. Computations

Computations to be made within IRIS/IOC will include four information acquisition opportunity exercises:

- o Airborne SIGINT
- o Airborne RADINT
- o Airborne PHOTINT
- o Surface RADINT

These evaluation requirements were specified to include performance measures and method of analysis. The first three will be limited to programs characterized by established routes; i.e., no user-input route data will be accommodated.

The specific requirements were specified by the following criteria:

- o Airborne SIGINT outputs will include cumulative acquisition time against an IRIS-user designated point target for each route that an identified information system is associated with. The analysis will assume geometric rather than radio line-of-sight as a concession to the omission of weather and EMCON effects on performance. Each segment of each applicable route will be described in terms of earth-centered vectors, as will be the designated target. Collection time on a segment will be computed in IRIS by determining the time, on the segment, when the target is within line-of-sight. The identified information system's nominal mission speed will be used. Orbit segments will be considered as separate discrete segments.
- o Airborne RADINT outputs will include cumulative acquisition time, for each route, against a user-designated boundary of an area target, and the fraction of this boundary against which collection could occur. The analysis will assume geometric rather than radio line-of-sight (although normally typical) as a concession to the omission of weather and sea-state effects on performance. Each segment of each applicable route, and the designated boundary target strip will be described in terms of earth-centered vectors. Collection time on a segment will be computed by IRIS by determining

the time, on the segment, when at least one point on the target strip is within line-of-sight. The identified information system's nominal mission speed will be used. Target strip coverage will be computed in IRIS by determining the Boolean sum of all segments of the target strip against which collection could occur. This will include any route segment from which the target strip is within line-of-sight. Radar performance will be enabled by the use of a partial solution of the standard radar range equation. This will be included in the ASCAP record associated with the information system being evaluated. This partial solution will consider all parameters except the target cross-section parameter which would be input by the IRIS user.

- Airborne PHOTINT outputs will include minimum and maximum depression angles of the line-of-sight from any applicable route segment to a user-designated boundary of an area target, and the slant ranges associated with these depression angles. Each segment of each applicable route will be described by earth-centered vectors as will be the boundary target strip. The analysis will consider the orientation of the camera relative to the platform roll axis. Slant ranges along the boundary lines-of-sight will follow routinely.
- Surface RADINT outputs will include data describing the slant range-altitude envelope associated with a surface radar operating against an IRIS user-designated airborne target (the subject of the current information requirement). This output will be implemented by the use of a partial solution of the standard radar range equation. This will be included in the ASCAP record associated with the information system currently being considered. This partial solution will consider all radar variables except the gain and target cross-section parameters. The gain will be computed, within this analysis, over a vertical angle through the radar boresight corresponding to the 25 percent range points. Boresight gain and vertical half power beam width, from the ASCAP record associated with the current information system will be used for this computation.

In each of the above data acquisition opportunity evaluations, the inputs required should be in keeping with the user's normal way of thinking (e.g., expression of locations, dates, and times). When the user is required to transfer data from an ASCAP or INTSIG record, it should be identified in the same manner as in the source record. Generic identifications will not be used.

SECTION V

SOFTWARE DEVELOPMENT

The established software requirements formed the specification for IRIS development. The end product is an user-oriented information display system. The software requirements of Section IV present the specifications for computer hardware, software operating system, programming language, data base structure, man/machine interface, and software operations that controlled the software development. Several enhancement techniques were incorporated during this development. The software was developed on the basis of two major functional divisions, i.e., data base file build programs and user-controlled executable IRIS. The user-oriented capabilities of IRIS are continuing to be validated.

A. SOFTWARE ENHANCEMENT TECHNIQUES

IRIS software development was significantly enhanced by several implementation techniques. These techniques were incorporated after recognizing the similarity of certain data files, the analysis dependency on the IRIS subject list, the need for free-form textual files, and the desire to interface through different user terminals.

A basis for a common software development approach was the functional similarity of several classes of files; e.g., the various Asset Capability (ASCAP) files and the different collection system Intelligence Signature (INTSIG) files. In the case of the ASCAP files, the structure was defined so that all types of information systems could be accommodated by the same ASCAP format. In the case of the INTSIG files, common retrieval and presentation software was developed to use a query subject cross reference record (unique for each INTSIG) in conjunction with an unstructured assembly of technical observables. The elements of these observables were appropriately flagged in the cross reference record.

The multiple use of the IRIS subject list in support of different IRIS analyses and presentations identified an opportunity for a single indexing vector map to be used in support of several analyses (e.g., the RIM analysis and the subject-peculiar INTSIG presentation). The IRIS conversion of the

SUCAT indentured identifications into an indexed array was amenable to efficient software manipulation.

Certain IRIS files (e.g., ASCAP and MSGFORM) do not require preprocessing and can be stored in the data base in any order convenient to the generating process. These file records were assigned unique data base names. The utility programs in RSX-11D, the IRIS computer operating system, were used to access these files instead of burdening IRIS with additional software requirements to develop vector maps or accessing software.

The use of SEND and RECEIVE subroutines instead of the normal Fortran read/write statements were used to facilitate the efficient evolution from an IOC/VT-52 terminal to the expected FOC Univac 1652 terminal. This software technique assured conversion simplicity in that only two well identified routines need to be modified when different terminal devices are incorporated.

B. FILE BUILD PROGRAMS

IRIS file build programs reorganize the analyst created data base files for easy access during IRIS execution. The functional flow of Figure 2 illustrates the relationship of the data base files to these interim programs. This figure indicates that three classes of data base files are used directly in the IRIS execution. The remaining files require associated file build programs to reorder and vector map the data for efficient operations and correlations during execution. The restructured files generated by these programs are stored on the disk subsystem for use in IRIS execution.

C. IRIS SEQUENTIAL EXECUTION

The sequential execution division of IRIS performs the screening process to determine candidate information system outputs, then allows the user easy access to pertinent stored information related to these outputs. This division of IRIS is illustrated by the sequential execution flow of Figure 2. The software for this division was developed so that a user can follow either a predefined execution sequence or an optional execution sequence. Either sequence allows the user to proceed through the functional operations of sign-on, RIM analysis, ASCAP textual review, and finally, IRIS Log review.

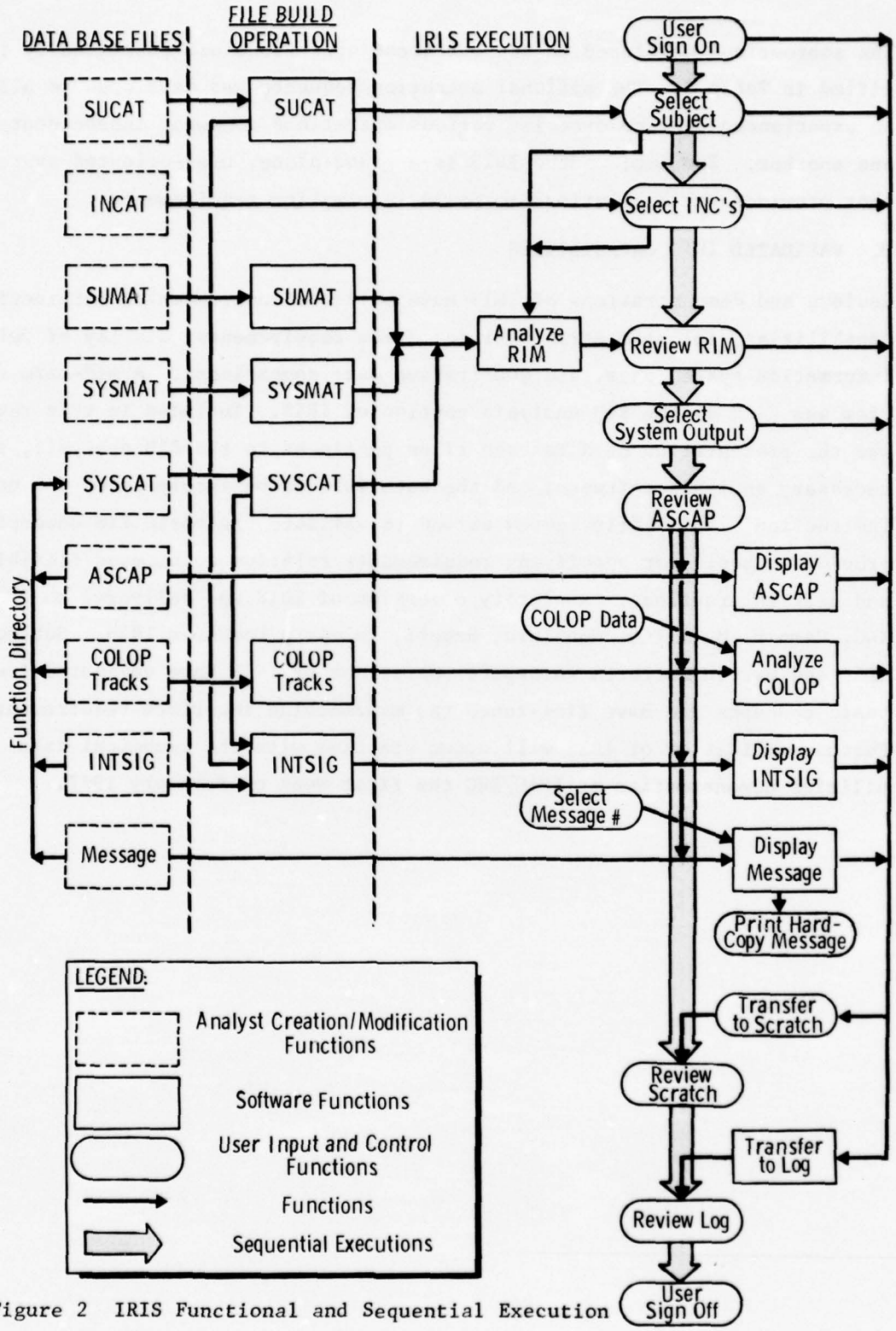

Figure 2 IRIS Functional and Sequential Execution

The subroutines developed to support these operations are functionally identified in Table 6. The optional execution sequence was developed to allow an experienced user to exercise various operations somewhat independent of one another. The implemented IRIS is a stand-alone, user-oriented system that provides rapid solutions to posed information requirements.

D. VALIDATED IRIS CAPABILITIES

Reviews and demonstrations of IRIS have validated user/machine interactive capabilities, interpretation of information requirements, display of relevant information system data, and qualitative user comparisons. A mid-term review was held of the RIM analysis portion of IRIS. Included in this review was the presentation of data base files pertinent to the RIM analysis, the necessary analysis software, and the tutorials to be incorporated for user instruction. This early review served to validate the basic RIM concept and provided a basis for specifying requirements relative to command flexibility and user interactions. A prototype version of IRIS was delivered to IPAC/IWC, Camp H. M. Smith, Honolulu, Hawaii, in early December 1976. Subsequent IPAC and Martin Marietta Aerospace operations of IRIS have validated its basic concepts and have fine-tuned the man/machine interface requirements. Further validation of IRIS will occur starting with the technical capabilities demonstration at IPAC/IWC the first week of February 1977.

TABLE 6 IRIS FUNCTIONAL OPERATIONS

FUNCTIONAL OPERATIONS	ALLOWS THE IRIS USER TO:
o Sign-On	Enter his name for IRIS Log identification
	Read the introductory tutorial
	Input an information requirement
o RIM	Select an intelligence subject
	Select a set of information need categories
	Examine the RIM solution candidates
o ASCAP Review	Display ASCAP files of output attributes
	Display intelligence signatures of the subject
	Analyze acquisition opportunities of the system
	Display message forms for possible tasking
o Log Review	Display IRIS Log of transactions during dialogue
o Sign-Off	Stop IRIS execution, IRIS processing completed

SECTION VI

DATA BASE AND ANALYSIS METHODS DEVELOPMENT

A. DATA BASE

1. Assembled Data

The data base components which fall into this category are the:

- o ASCAP (Asset Capability) Files
- o SYSCAT (Information System Output Catalog)
- o INTSIG (Intelligence Signature) Files
- o MSGFORM (Message Form) Files
- o TRACKS (Data Acquisition Track) File

a. Asset Capability (ASCAP) Files

The ASCAP files serve two functions in IRIS:

- o A central location where descriptors of the information system and information system output are assembled for the user's review.
- o The operational location within IRIS from which a user can branch to either more detailed analyses of the information system or to the initiation of output acquisition actions. Either of these options require data which are stored in ASCAP files.

The support of these two ASCAP functions implies a variety of data for any one information system and further variations for different types of information systems. The construction of the ASCAP was defined to permit the inclusion of many data variations extracted from reference reports and/or interviews without attempting to force such data into an artificially constrained format. To facilitate an easier review by the IRIS user, the major sections were structured in an indentured manner. For example, the Output Content section describes all the information in the output, including, as applicable, such things as:

- o Generic output information
- o Geographic constraints associated with the output information.
- o Processing effects on the information.
- o The autonomy of a single output (relative to sequential issues of the output).

To highlight each of these, a major indenture is used with subindentures if the major division is modified or requires finer grained detail.

It was apparent that some of the sections within a given ASCAP would either be very detailed at IOC or else would grow rapidly as the IRIS user became aware of more facts about the information system and added them to a specific ASCAP file. Such incremental growth, if not disciplined, could inhibit IRIS from leading users rapidly to the selection of the most promising information system outputs, if the user had excessive ASCAP material to review. Accordingly, it was determined that a brief (less than a single display page) executive summary was needed. Information system and output highlights were assembled in this lead section. This will permit the user to accomplish one of two ends:

- o Establish whether or not the content of a particular ASCAP file would be relevant to the current query, and thus minimize his involvement in manual review efforts.
- o Enable him to validly reject the particular information system without having to review a complex ASCAP record.

To further facilitate the use of these data, each ASCAP file has been paginated and the user can determine from a table of contents following the executive summary where he should look for data of particular interest to him.

b. Information System Output Catalog (SYSCAT)

The SYSCAT serves two functions in IRIS:

- o It provides abbreviated summaries of the salient attributes of information system outputs which are used to identify candidate solutions to queries. Sufficient information about each output is presented to allow the user to decide on the value of additional review of a displayed solution.
- o It provides a record in which identifiers of other pertinent files or analysis procedures, uniquely associated with the output, can be stored. These identifiers enable subsequent software access of the appropriate intelligence signature files, data acquisition opportunity analysis and applicable standard message formats. These identifiers also serve as indicators of the existence or

non-existence of specific file records. Every SYSCAT element should be associated with an ASCAP record. However, in the event that an ASCAP has not yet been developed, a SYSCAT element may still be displayed as a potential query solution.

c. Intelligence Signature (INTSIG) Files

INTSIG files were conceived as repositories of data that would serve two objectives:

- o Provide data for user review and software operations, the results of which would validate (or invalidate) the technical compatibility between a given information system and a given subject.
- o Provide data on information requirement subjects (the targets of information system data acquisition) which would be germane to the evaluation of data acquisition opportunities.

It was recognized that accomplishment of either objective should be characterized by a rapid convergence to the specifically applicable signature. The value of INTSIG information relative to the solution of an information requirement would be small (as compared to that which would be derived from review of an ASCAP file) and so an inordinately long analysis should be avoided. Since IRIS software keeps track of the current query subject, it was only necessary to define INTSIG pointers that would enable the software to retrieve and present the signature data related to a given query subject. This was accomplished by development of subject signature to subject category correlations wherein the subject categories were associated with signatures related to specific collection disciplines.

It was also recognized that the type of information presented via the INTSIG would vary considerably from one signature type to another. For example, ELINT signatures can identify applicable radars and associate enough operating or technical data to confirm the identified information system; whereas PHOTINT signatures can only express resolution required to achieve different levels of identification. Consequently, it was appropriate to allow the INTSIG files to vary in format for different collection disciplines as required. These INTSIG files were developed for IRIS:

- o ELINT - Radar identification, primary function, radio frequency ranges and vertical beam widths.
- o PHOTINT - Resolution required to achieve the four levels of identification specified by IRIS information need categories.
- o RADINT - Radar cross section vs. aspect angle at a reference radio frequency.

ACINT and IRINT signature data were not developed for IRIS/IOC.

d. Message Form (MSGFORM) Files

The MSGFORM files are models of the standard messages which are to be used to formalize an IRIS user's informal request to access a particular information system output. These models can include action and information addressees identified and with all the message elements, that the information system protocol requires.

e. Data Acquisition Track (TRACKS) File

The data for this file were obtained from sets of established data acquisition tracks and, for IRIS/IOC, required only a minimum of analyst editing.

2. Derived Data

These files contain the source data by which queries are posed to the system and from which candidate solutions to queries are derived. They are:

- o Intelligence Subject Catalog (SUCAT)
- o Information Need Category (INC) File
- o Subject Matrix (SUMAT) File
- o Information System Output Analysis Matrix (SYSMAT) File

a. Intelligence Subject Catalog (SUCAT)

As noted in Section III, the concept of a query subject as the principal focus of the IRIS user's information requirement implied the need for an IRIS subject list with which the subject of a given query could be correlated. The set of subjects that compose the SUCAT was developed under sponsorship of a Martin Marietta new space Independent Research and Development (IRAD) Task.

b. Information Need Category (INC) File

As noted in Section III, INC data is a categorization of what is required to be determined about a query subject. As such, it is used in two ways:

- o As a complement to the SUCAT correlation in the presentation of a query to IRIS.
- o As the focus of the analyses described in Subsections c. and d.

The INC data was developed prior to the development of IRIS under Martin Marietta Aerospace IRAD sponsorship.

c. Subject Matrix (SUMAT) File

As noted in Section III, the derivation of solutions to user queries was accomplished by forming the dot product of two n-tuple vectors where n is the cardinal of the information need categories. One of these is a unit vector that describes which INC could be satisfied by outputs of a collection discipline associated with observables of an IRIS subject. The method by which the first of these vectors (the SUMATs) are derived is:

- o All observables of a given subject are identified. The collection discipline(s) that could detect or measure each of these observables are identified. Also, the types (as indicated by their subject matter) of intelligence files which may be associated with the subject are identified.
- o Which information need categories could be satisfied, to any degree, by each identified collection discipline or file type are identified. This determination is independent of a specific information system or intelligence file.
- o SUMATs for all subjects at the same indenture level are then logically summed to form the SUMAT for the next higher level of subject indenture.
- o The subject's membership in both of the following subject supersets are designated.
  - o Land, air/space, riverine/ocean
  - o Equipment/installation, activity/event, organization/structure

  This subject superset designation enables the IRIS query solution analysis to eliminate illogical solutions.

d. Information System Output Analysis Matrix (SYSMAT) File

The second of the two vectors referred to in Subsection c. above is the SYSMAT. This is a vectoral summary of how well a specific information system output satisfies the INC elements. The method by which this vector is derived is to:

- o Determine which INC elements can be satisfied as presented by the Output Content section of the related ASCAP.
- o Determine how well these INC elements will be satisfied, as presented by the Output Quality section of the related ASCAP.
- o Designate the applicability of the output to the subject supersets listed in Subsection c. above. Verifying subject superset commonality will screen out illogical query solutions.

B. ANALYSIS METHODS

Methods were developed for acquisition opportunity evaluation within IRIS.

1. Airborne SIGINT

This analysis is implemented by the following method:

- o Incremental testing of each track segment to identify at least one valid point from which collection could occur.
- o For candidate segments, determination of the distance along the segment when target is within line-of-sight and conversion of this distance to elapsed time using input platform speed.
- o Accumulation of collection time for all eligible segments on a given track and outputing this cumulative time as a measure of the platform's capability on that route.
- o Repetition of the above for each track identified with the information system in the related ASCAP record.

Required inputs by the user are latitude, longitude, and elevation of the target point and information system speed (from the pertinent ASCAP file).

2. Airborne PHOTINT

This analysis is implemented by the following method:

- o Incremental determination of which track segments are candidates for collection based on the relationship between line-of-sight vector and sensor boresight orientations to at least one point on the user-designated target strip.
- o For the candidates identified above, determination that geometric line-of-sight to at least one point on the target strip exists.
- o Determination of minimum and maximum slant ranges.
- o Determination of minimum and maximum depression angles, associated with these slant ranges.
- o Cumulative segment testing of depression angles to enable the output for the entire track to reflect best and worst collection capability.
- o Repetition of the above for each track identified with the information system in the related ASCAP record.

Required inputs by the user are latitudes, longitudes, and elevations of the two end points of the target strip that form a boundary of a target area of interest.

SECTION VII

SYSTEM LIMITATIONS

Three principal categories of IRIS limitations are discussed in this section:

- o System design and system operations
- o Data base
- o Analysis methods.

A. SYSTEM DESIGN AND SYSTEM OPERATIONS LIMITATIONS

This subsection discusses identified display and utility limitations of IRIS. Those thus far identified do not represent weaknesses in the basic system, but rather, convenience and sophistication omissions. The limitations presently identified are summarized below:

- o Excessive user review and decision-making actions are required within the current IRIS process. IRIS design was predicated on the user being responsible for making comparisons between system capabilities and information requirements as the basis of his decision-making. If critical threshold values were available for these comparisons, this review and decision process could be streamlined and included to a greater degree in the IRIS software.
- o IRIS design was originally influenced strongly by the planned use of a dual scope display terminal. The present system uses only a single scope or hardcopy device as the terminal. The late change in display philosophy led to an awkward method of comparing the various data from ASCAP, INTSIG, message form and scratch files. The incorporation of the dual scope display terminal would alleviate much of this limitation. A related software deficiency is the current inability to extract parameter values from an ASCAP for automatic transfer, as input, to the various acquisition opportunity evaluations. Correction of this deficiency involves a fairly major software modification.
- o Data base editing of IRIS files is restricted to an off-line activity. The data base files cannot be revised while IRIS is being operated. Changes required by the user must be noted for later editing and rebuilding of the file(s). Editing during IRIS operation would not

be efficient. However, a semi-automated process could be implemented whereby the user could easily leave IRIS, correct the desired file, initiate an automatic file rebuild, and return to IRIS to continue his analysis with corrected file information.

B. DATA BASE LIMITATIONS

The data base development for IRIS was not as complete as originally planned, as evidenced by the lack of certain classes of information system outputs and data voids within the files. IRIS development did endeavor to define the specific file elements and an ensembled arrangement for each distinct type of information system appropriate to IRIS. This set of files will be a useful model for the ultimate expansion of the various IRIS data bases. Limitations with respect to specific files are as follows:

1. ASCAP Limitations

The scope of the IRIS data base was originally expected to include in excess of six hundred discrete information system outputs, each of which would be characterized by a unique ASCAP file. Only a small portion of these outputs were eventually included in the IRIS data base. However, it is recognized that of the potential set of ASCAP files, many may not be viable sources for candidate solutions because of tasking inaccessibilities or reporting timeliness. The lack of a broad representation of outputs does present a potential weakness in the effectiveness of the IOC system.

2. INTSIG Limitations

The INTSIG data base file was originally defined to relate IRIS intelligence subject signatures with five collection disciplines. Three of these collection discipline to subject correlations have been accomplished, to the degree noted:

- o ELINT - 95%
- o PHOTINT - 100%
- o RADINT - 25%

The other two collection disciplines required data that could not be specified within the allotted program development time. However, the information system outputs included in IRIS/IOC did not identify ASCAP records that would require either of these INTSIG files.

3. SYSCAT Limitations

The SYSCAT file identifies more information system outputs than are included in corresponding ASCAP files. Some information system outputs are well enough identified to permit the generation of a SYSMAT record but sufficient data was not available to justify a corresponding ASCAP record. Consequently, IRIS/IOC can identify certain candidate solutions that cannot be reviewed in detail.

4. MSGFORM Limitations

Data in this file are derived from the same sources as is the ASCAP Access Methods data. Consequently, deficiencies in this latter area will also be reflected in this file.

5. Data Base Structure Limitations

The SUMAT and SYSMAT files, from which the RIM analysis is derived, were defined without prior knowledge of the number or type of candidate solutions that could result. More information need category satisfaction resulted from the independent SUMAT and SYSMAT analyses than was originally anticipated, with many of the RIM solutions being illogical. The Application Category assignments, in both the SYSMAT and SUMAT analyses, was incorporated to prevent the identification of these illogical solutions. This limited function of the Application Category assignment was reflected in the early definition of SUMAT and SYSMAT formats which currently cannot accommodate any additions in either the Information Need Categories or the Application Categories. This latter limitation, particularly, is a significant handicap relative to correction of the surplus solution syndrome.

C. ANALYSIS METHOD LIMITATIONS

Various analyses were required to support the generation of the IRIS data base files. The analysis methods used were simplified wherever the results would not adversely influence the final results. Also, certain performance refinements were not included in the ASCAP descriptions of sensors nor reflected in the sensor performance that could be required in selected acquisition opportunity evaluations.

As examples of these limitations, IRIS/IOC did not include atmospheric or clutter effects in the RADINT performance evaluations even though developed models of these effects were available. In the case of airborne ELINT information systems, the corresponding ASCAP descriptions did not characterize DF accuracy as a function of target emitter RF. The acquisition opportunity analyses included in the IRIS/IOC do not evaluate all possible types of information systems. Also, the analyses included are based on somewhat simplified methods and limit the number of target and information system parameters.

Sophistication of these analyses should be postponed until the user of IRIS becomes familiar with the results of these analyses and can determine that such data will be useful in the execution of IRIS decisions.

SECTION VIII

CONCLUSIONS

IRIS/IOC is a functionally complete intelligence data support system that can be used to facilitate the identification and selection of information system outputs, as solutions to posed queries. IRIS consists of an all-source data base, working files developed on-line to support the analysis of user's queries, and a flexible operating command structure responsive to a functional man-machine interface. The system has been designed to permit intimate involvement by the user. This includes the specification of problems to the system, the presentation of stored and generated data, and the interpretation of presented data in the form of user's decisions. The system was also structured to encourage growth of both the various data bases and the software-controlled procedures and presentations. IRIS/IOC can be considered a prototype system. The evolution into IRIS/FOC would require expansion of the various types of data files using the formats defined during this development. Data and software enhancements that could be imposed would be required only to reduce the time required for the IRIS analysis processes.

IRIS software design was defined to accommodate both the IOC system functional requirements and the evolution into an enhanced FOC system. Analyst-created data files were so defined that incremental growth of this data base could be handled with no impact on software design. IRIS data file build software has been designed so that incremental additions to the data base can be reflected in these IRIS files without the system having to be taken off-line. IRIS system software design has been structured so that eventual use of different terminal devices will require minimal changes to the software interface. Inherent RSX-11D (the operating system software) capabilities have been exploited effectively to minimize IRIS software complexity.

The various components of the IRIS data base have been assembled and structured so that in IRIS/IOC there is a complete model of records for all the data types that would be required in IRIS/FOC. This will minimize the effort required to eventually complete this data base. For data types that

are devoid of data in IRIS/IOC, the data base development requirements have specified the data elements precisely enough so that their eventual addition to IRIS will require a minimum of analytical effort.

The analytical capability within IRIS/IOC was constrained to provide minimal evaluation results. However, the capability that does exist could be increased by simple additions to the existing software. It is anticipated that as user familiarity grows he will recognize the needs for sophistications that would assist him in the selection of candidate information systems. The simplifications, vis a vis what conceivably would be required as an ultimate capability, have been specifically described. The manner in which IRIS/IOC could readily assimilate such changes has also been described.

The scope of this development did not permit the optimization of the man-machine interface in IRIS. This part of the IRIS/IOC design was limited to a functionally usable, albeit non-optimum, capability. As IRIS/IOC is used initially, the users will require very detailed explanations of the what and why of the directed procedures. The periodic assignment of new personnel to the IPAC Watch team will continue to justify the more detailed attributes of this interface. As the IRIS users' experience with IRIS grows, their dependence on IRIS for operating guidance will decrease accordingly. This variable level user direction is that to which the design response was non-optimal.

Numerous software and data base changes that would enhance the operating efficiency of IRIS became apparent during the pre-IOC validation of the system. In addition to the obvious data base completion-related additions, these enhancements include:

- Enable those user review and decision functions with software, when ADP can reliably execute those functions.
- Simplify the data base modification so that they can be reliably carried out by the routine IRIS user.
- Modify the man-machine interface so that, at the least, there are sufficient operational short cuts to enable the experienced user to execute IRIS rapidly.

These enhancements are discussed in detail in Section IX of this report.

Although the IRIS/IOC utility to support day-to-day operations is limited by its current data base, it has sufficient power to serve as a tool to train users and to enable users to determine which of the identified enhancements should be implemented and how these improvements should be prioritized.

SECTION IX

RECOMMENDATIONS

A. SYSTEM ENHANCEMENTS

During the last half of the system development and the pre-IOC validation testing of IRIS, the potential value of a number of software, man-machine interface and data base enhancements became apparent. During the actual design of IRIS, these system refinements were not anticipated, principally because the system was not being "experienced"; only specified. The permuted number of intelligence subjects, information need categories, collection disciplines, information system outputs, intelligence signatures, access protocols, and information system technical/operational characteristics, was significantly larger than the specifications for any one of these parameters indicated. Further, the effect of such a large volume of data (which must be reviewed relatively quickly) on the user's ability to assimilate information, was not anticipated unti a complete data base was available at the time of system validation. The causes of these phenomenologies, however, are not limited to just the man-machine interface parts of IRIS. Operating software simplifications and data base deficiencies and simplifications are also involved. For example, an ASCAP record that does not describe the output comprehensively enough, can result in a SYSMAT that overqualifies the information system. This forces the IRIS user to cope with more information requirement solutions than necessary. Many of the changes to IRIS that would reduce any current awkwardness in carrying the user efficiently to his information solution or to increase the utility of IRIS as a general intelligence-related data base are discussed in the remainder of this section. Other potential enhancements to IRIS are included in the supplement to this technical report.

1. Information Requirement Input

IRIS/IOC requires the user to spend time and effort in designating subjects and information need categories to model his information requirement for the system. The simplification (for the user), and the increase in comprehension (for IRIS) of these tasks, compose this class of system enhancements.

a. Subject Selection

Subject selection by IRIS could involve the user indicating what he thinks the subject of his requirement is (without reference to the detailed IRIS concantenation) followed by an IRIS search of a synonym list; the elements of which are correlated with the SUCAT (the IRIS subject list) identification numbers. Failure of the software to find the designated subject in the resident IRIS synonym set would result in the user being prompted to change his subject word. Such initial "failures" in the subject selection would also prompt the user to have his initial designation added to the synonym list.

b. Information Need Correlation

For IRIS to correlate the information needs of the requirement with its own set of information need categories would be somewhat more involved. IRIS could be charged with the identification of key words/phrases in the designated information requirement prior to correlation with the IRIS information need categories. The preparation of the key word/phrase set was actually undertaken informally as part of the original definition of the information need categories. The summary of different classes of information needs into the present "categories" is seen simply as the inverse of what is now required in this enhancement. One additional complication, however, would involve the addition of certain attributes to the IRIS subject list; i.e., certain state or action qualities do not apply to certain subjects. With the subjects so identified, this IRIS enhancement would only assign valid information need categories, regardless of how the query was posed.

c. Information Requirement Constraints

Another information requirement specification enhancement that now appears desirable would permit the user to limit the analysis by applying constraints related to the information requirement early in the analysis process. An example of this is the geographic area which contains the subject of interest. IRIS/IOC allows the user to consider geographic constraints in the acquisition opportunity evaluation. This can only be done after he has

reviewed candidate solutions. Some of these may be geographically illogical. The specification of a geographic area and the consequent identification of applicable information systems, by IRIS, would be analogous to the identification of a subject by IRIS. The user would specify the geographic area and IRIS would search a synonym list to match the geographic area to an area number. In this case, however, the IRIS country/geographic area list would use already developed and proven geographic locators as the basis of this synonym set (analogous to those used in the PACOM HUMINT collection requirements system). As in the case of the subject synonym list, a failure to match would be reflected in a prompt to the user to re-designate an area. The use of this identified geographic constraint would require two additional IRIS modifications. The IRIS/IOC ASCAP files (see Section VI) are based on unique information system outputs. Multiple origin locations of these outputs are discussed within the record. There is no reason why such a single ASCAP record cannot be expanded into a sequence of records each differing only by the area/country for which the output data is acquired. (More mass storage would be required, but IRIS/IOC uses less than ten percent of that which is available.) Such discreteness in the ASCAP structure would permit a corresponding increase in the specificity in the related SYSMAT data, which is one of the two bases of the information requirement solution. Inclusion of a country or geographic area code in the SYSMAT would be accommodated in a manner similar to that presently used to designate Application Categories in the SYSMAT analysis. For IRIS to use this additional data would be a simple extension of the present RIM analysis. Currently, IRIS verifies a match between Application Categories in candidate SYSMATs and SUMATs before verifying information need category matches. To verify geographic area or country compatibility, IRIS would merely have to match the identified country code(s) with those indicated in the candidate SYSMAT's.

2. On-Line Editing

Two types of on-line editing are presently seen to be desirable added capabilities:

- o Permitting the user to "write" on the IRIS scratch file or to fill in an IRIS formatted message; and
- o Exploitation of the RSX-11D (the operating system used by the IRIS computer) Line Text Editor in conjunction with existing IRIS file build software to facilitate the updating of IRIS data base files.

The IRIS/IOC scratch file is slaved to data displayed routinely to the user. This denies the user the opportunity to make "notes" to facilitate his ultimate decision making. This software-related change would permit user inputs to the system. Presently, IRIS displays data which helps the user to prepare request messages. The addition of an edit capability would permit the user to prepare these messages on the IRIS terminal, using the defined formats in the MSGFORM file.

It would be possible to integrate the existing IRIS file build software and the RSX-11D Line Text Editor so that the file update and correction task will be simplified. It is suggested that this software modification would permit the modification of the card image versions of the IRIS files to be followed automatically by execution of the file build programs.

3. Adaptation to Univac 1652 Terminal

The design concepts on which the current IRIS are based were established on the basis of the output data being presented on a dual-tube display terminal, the Univac 1652. This terminal was originally a part of the defined IRIS hardware system. Scheduling problems during the system development forced a mid-term change in the system activation plans that resulted in IRIS/IOC being used with a single-tube display. Since there wasn't time to completely redesign IRIS when this decision was made, it was necessary to require the user of IRIS/IOC to either: remember data that he needs for subsequent steps in the analysis process, or to continually page back to prior displays to retrieve such data. The dual tube presentation would significantly reduce such procedural complications. Additionally, the Univac 1652, in its function as a "smart" terminal, could implement IRIS commands in IRIS/IOC. This dual tube terminal can also be used to display information graphically, which could enhance IRIS information presentation.

4. Automation of User Functions

Presently, the IRIS user is required to perform manual comparisons between information system capabilities and that which would be needed to develop information about the query subjects. The user is also required to input data from one or more of the reference files into the acquisition opportunity analysis. The user comparisons, particularly the technical validations of the information system candidates, could be accomplished via software techniques. The INTSIG (intelligence signature) files are structured so that a specified subject (of an information query) specified to the system will permit only the applicable signatures (PHOTINT, ELINT or RADINT) to be displayed to the user. These signature data are not rigidly formatted. The related technical capability of the information system being evaluated is also stored in an unformatted manner. However, it would be possible to restructure both of these data ensembles to the extent necessary to permit a comparison via software. This comparison could be accomplished as a part of the query interpretation analysis. In IRIS/IOC, the user can eliminate candidate solutions, but only after he has involved himself in a review of presented information system outputs.

IRIS/IOC requires the user, during the review of the candidate information systems, to note certain data which is required as input to the subsequent acquisition opportunity analyses. Such data could be more efficiently accumulated in a separate array in which its location and identity are defined. Then, when an acquisition opportunity analysis is directed by the user, this data would be carried over automatically.

5. Casual Review of IRIS File Review

IRIS/IOC has a primary mission of supporting the solution of information requirements or queries by facilitating the selection of candidate system outputs which could contribute to these solutions. This process involves the use of various data files, the content of which could be of use to non-typical IRIS users. In order that such use be made of these files, two software modifications would be effective aids.

a. Simple File Review

A simple file review (without any edit capability) would be one of these modifications. This could involve only a file call-up and the use of the existing paging and printing commands. This would be particularly useful for analyst review of various ASCAP data, either for the purpose of reviewing the quality of such data or for extracting data applicable to an analysis problem.

b. Specialized Search Criteria

An extension of the above file review, also tailored to the use of IRIS by analysts who have an interest only in specific files, would enable queries, characterized by recognized search criteria, to be answered. The ASCAP data is the focus on this recommendation. As presently structured, IRIS ASCAP records are free-form text records and thus, do not lend themselves readily to ADP queries. However, each of these records is prefaced by an executive summary which could be restructured in a manner that would support this proposed modification. An alternate approach would involve the creation of a code set invisible to the user but associated with each ASCAP record. In this code set, certain key attributes of the information system or the output for which the ASCAP record exists would be identified. This code set would be analogous to the set of pointers associated with the SYSCAT and used to present a potential solution to an information requirement to the IRIS user. These pointers identify applicable file records which are associated with the identified output and enable IRIS/IOC software to know where it has to go when certain commands are executed. In the case of this proposed enhancement, these transparent identifiers could indicate: type of information system, a range in which the output timeliness falls, a time span in which the output accuracy or uncertainty falls, owner/operator, frequency of reporting, etc. Such a set of screening parameters would be convenient but inflexible if other system or output parameters were specified. The advantage, of course, is that the existing records would not have to be forced into a format that would complicate subsequent data base maintenance.

6. Dialogue Modifications

The man-machine interface in IRIS was developed on a purely functional basis. This involved the determination of what the user had to do to enable progression to subsequent IRIS analysis phases, and the translation of these tasks into instructions to the user. This interface was not optimized. It is proposed that optimization could be achieved by the use of a dialogue synthesizer, such as has been developed by the Martin Marietta Man Computer Interface Laboratory.

7. Remote or Multiple Terminals

Two possible enhancements are recognized: namely, multiple terminals hard wired to the IRIS computer and, modification of IRIS software so that the IRIS computer can become an IDHS-C node.

RSX-11D, the operating system on the IRIS computer, has the inherent capability to support multiple users, providing certain accessing protocols are incorporated into IRIS software. This is a well-defined procedure but was not executed in the building of IRIS/IOC.

For IRIS to serve as an IDHS-C node, software changes would be required. For instance, modifying the FICPAC switch so that it recognizes the IRIS computer and, modifying IRIS software so that it could readily validate the clearance of users at remote IDHS-C nodes relative to their right to access IRIS data.

B. OTHER SYSTEM APPLICATIONS

1. Technical Intelligence

Although IRIS/IOC is intended to be used to support the resolution of current intelligence information requirements, its analysis structure (i.e., the development of candidate solutions to posed queries and the presentation of various data which provide in depth discussion/understanding of these possible solutions) could support the technical intelligence analyst. The frame of reference in which such an analyst would use an IRIS-type tool, however, would not have the objective of initiating data acquisition or influencing processing. Rather, this use would be concerned with the

identification of sources of data that may not be routinely available, or, of collateral data sources which may complement the more routine inputs to his analysis. To use the IRIS query interpretation process, the subject list would have to be more discrete. Those subject categories that are encountered only in operational or political scenarios would be eliminated. The information need categories would also require revision to reflect more specifically what is characteristic of a technical intelligence query. Many of the current IRIS information system outputs have no technical intelligence value. These would be eliminated. Sources ignored in IRIS/IOC, because their typical technically oriented product has little or no value to an operational intelligence consumer, would replace some of the present information system data. Consequently, the present IRIS SUMATs and SYSMATs would have to be re-created. The consequent solutions to posed queries would identify, generally, different outputs than are now presented. There would continue to be a need for the subject intelligence signature analysis, but the collection opportunity analysis and the message preparation parts of IRIS would not be required.

Experienced analysts may not be the users of this adaptation of IRIS. It would, however, be a useful tool for training, or for use by analysts whose experience with intelligence products is limited to a single collection discipline.

2. General Applications

The requirements interpretation analysis is not limited to intelligence problems. It is a technique that can be effectively used in any environment in which there is a need to develop answers to questions on a variety of subjects in a short period of time. Further, when the answers to such questions could potentially be imbedded in a relatively large number of sources (large compared to the number of sources with which a single individual or a small group of individuals could be intimately familiar) then the likelihood is small that the query will be posed by an individual who can infer an optimum solution without extensive help or delays. In such an environment, the IRIS requirement interpretation process represents a structured approach to identification of information sources which, in turn, can

be briefly described so that the questioner can rapidly perform in a priori evaluation of the potential source.

3. General Screening Processes

The RIM analysis screening process could be applied to the screening of other types of data; e.g., libraries, personnel expertise, other assets, etc., to determine candidate solutions to various problems.

METRIC SYSTEM

BASE UNITS:

Quantity	Unit	SI Symbol	Formula
length	metre	m	...
mass	kilogram	kg	...
time	second	s	...
electric current	ampere	A	...
thermodynamic temperature	kelvin	K	...
amount of substance	mole	mol	...
luminous intensity	candela	cd	...

SUPPLEMENTARY UNITS:

plane angle	radian	rad	...
solid angle	steradian	sr	...

DERIVED UNITS:

Acceleration	metre per second squared	...	m/s
activity (of a radioactive source)	disintegration per second	...	(disintegration)/s
angular acceleration	radian per second squared	...	rad/s
angular velocity	radian per second	...	rad/s
area	*square metre*	...	m
density	kilogram per cubic metre	...	kg/m
electric capacitance	farad	F	A·s/V
electrical conductance	siemens	S	A/V
electric field strength	volt per metre	...	V/m
electric inductance	henry	H	V·s/A
electric potential difference	volt	V	W/A
electric resistance	ohm		V/A
electromotive force	volt	V	W/A
energy	joule	J	N·m
entropy	joule per kelvin	...	J/K
force	newton	N	kg·m/s
frequency	hertz	Hz	(cycle)/s
illuminance	lux	lx	lm/m
luminance	candela per square metre	...	cd/m
luminous flux	lumen	lm	cd·sr
magnetic field strength	ampere per metre	...	A/m
magnetic flux	weber	Wb	V·s
magnetic flux density	tesla	T	Wb/m
magnetomotive force	*ampere*	A	...
power	watt	W	J/s
pressure	pascal	Pa	N/m
quantity of electricity	coulomb	C	A·s
quantity of heat	joule	J	N·m
radiant intensity	watt per steradian	...	W/sr
specific heat	joule per kilogram-kelvin	...	J/kg·K
stress	pascal	Pa	N/m
thermal conductivity	watt per metre-kelvin	...	W/m·K
velocity	metre per second	...	m/s
viscosity, dynamic	pascal-second	...	Pa·s
viscosity, kinematic	square metre per second	...	m/s
voltage	volt	V	W/A
volume	cubic metre	...	m
wavenumber	reciprocal metre	...	(wave)/m
work	joule	J	N·m

SI PREFIXES:

Multiplication Factors	Prefix	SI Symbol
1 000 000 000 000 = 10^{12}	tera	T
1 000 000 000 = 10^{9}	giga	G
1 000 000 = 10^{6}	mega	M
1 000 = 10^{3}	kilo	k
100 = 10^{2}	hecto*	h
10 = 10^{1}	deka*	da
0.1 = 10^{-1}	deci*	d
0.01 = 10^{-2}	centi*	c
0.001 = 10^{-3}	milli	m
0.000 001 = 10^{-6}	micro	μ
0.000 000 001 = 10^{-9}	nano	n
0.000 000 000 001 = 10^{-12}	pico	p
0.000 000 000 000 001 = 10^{-15}	femto	f
0.000 000 000 000 000 001 = 10^{-18}	atto	a

* To be avoided where possible.

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